United States Patent

Theodore

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[54] ELECTRICAL ADJUSTMENT OF TIME-CONSTANT APPARATUS

[72] Inventor: **Charles Theodore,** Huntington Beach, Calif.

[73] Assignee: **LTV Ling Altec, Inc.,** Anaheim, Calif.

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[52] **U.S. Cl.** **307/293,** 307/265, 331/113

[51] **Int. Cl.** **H03k 3/10**

[58] **Field of Search** 307/265, 273; 331/113

[56] **References Cited**

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Primary Examiner—Donald D. Forrer
Assistant Examiner—R. C. Woodbridge
Attorney—Harry R. Lubcke

[57] **ABSTRACT**

An auxiliary circuit for adjusting the time-constant of electrical apparatus, such as that of a relaxation oscillator having resistor-capacitor time-constant circuit elements. The adjustment is maintained while an electrical adjusting signal is present. This biases a transistor into conduction and places a second resistor in parallel with the basic resistor of the time-constant circuit, thereby reducing the time-constant. Alternate embodiments selectively allow plural adjustments, also adjustment of plural separate electrical devices.

2 Claims, 4 Drawing Figures

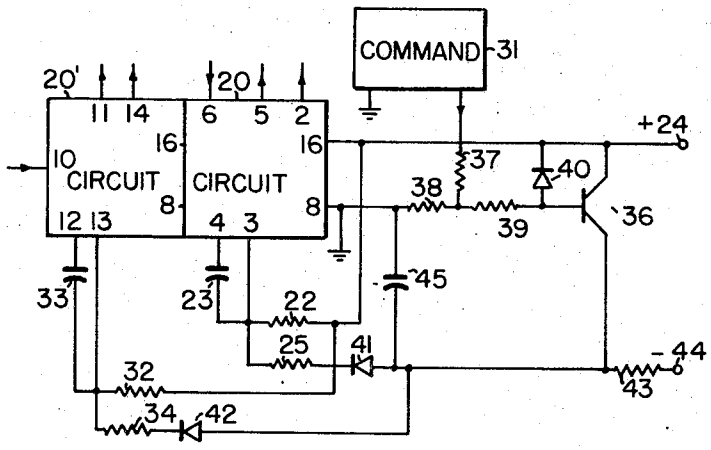


FIG. 1.

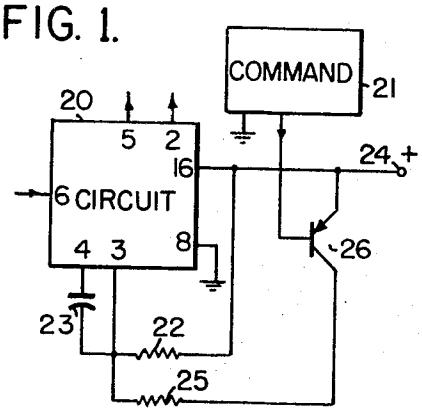


FIG. 2.

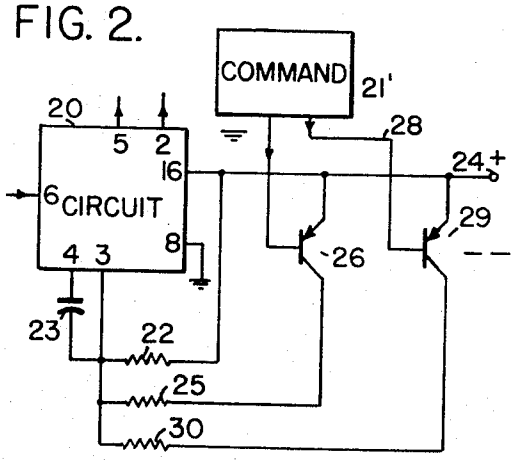


FIG. 3.

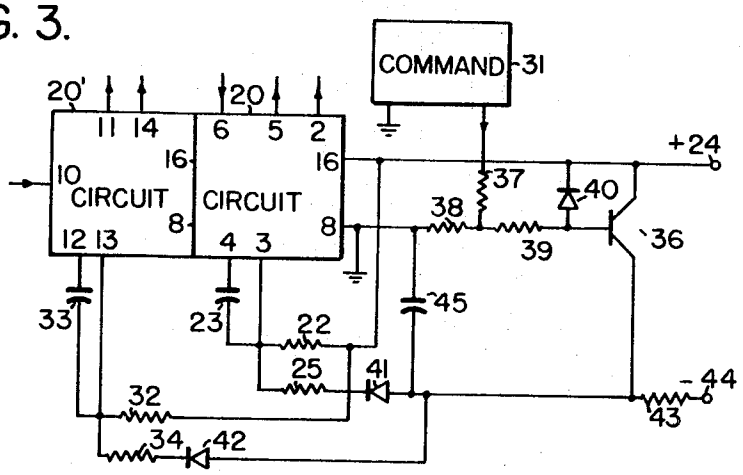
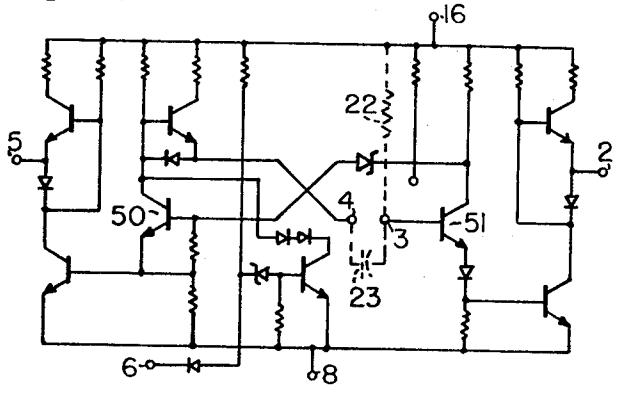


FIG. 4.



INVENTOR
CHARLES THEODORE

BY Harry R. Lubcke
AGENT

ELECTRICAL ADJUSTMENT OF TIME-CONSTANT APPARATUS

BACKGROUND OF THE INVENTION

This invention pertains to the alteration of an electrical characteristic of a device that occurs in the presence of an electrical signal in an auxiliary circuit.

The prior art has altered the period of time-constant circuits by physically connecting additional circuit elements to the basic time-constant circuit. This has been accomplished by manual switching, relay switching, or by means of a motor-driven switch.

The prior art has also altered the voltage to which a time-constant resistor is returned, thereby altering the time required to charge the associated capacitor to the voltage at which relaxation takes place in an oscillator of the relaxation type. However, this requires that the altered voltage be regulated so that the relaxation period is stable and repeatable.

SUMMARY OF THE INVENTION

In essence, a non-critical amplitude of electrical energy determines that an additional element shall either be included or excluded from functioning coactively with a similar type of element that is permanently connected in circuit.

Typically, a second resistor is placed in parallel with the resistor of a resistor capacitor time-constant circuit by current flow through a semiconductor device that is auxiliary to the main circuit. More than one resistive element may be placed in parallel by including additional semiconductor devices, which may be selectively caused to conduct. Also, one control circuit can be arranged to add an additional time-constant element to each of plural separate electrical devices. A unilateral conductor is included in series with each additional time-constant element. It is back-biased when the additional element is to be excluded from the permanent circuit and forward-biased when the additional element is to be included.

Only the presence of a command signal is required for actuating the auxiliary circuit. The amplitude of that signal is not critical and may vary over relatively wide limits without affecting the performance of the circuit that is adjusted.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram of a time-constant circuit apparatus to which an additional resistive element is added by the presence of a signal in an auxiliary circuit.

FIG. 2 is the same for selectively adding either or both of two additional resistive elements.

FIG. 3 is a schematic diagram for individually adding resistive elements to each of two time-constant circuits while retaining isolation of these circuits.

FIG. 4 is the schematic diagram for one monostable multivibrator, which is typical of those shown in block form in the other figures.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In FIG. 1 block **20** indicates a typical circuit, the time-constant of which is reduced during the presence of an auxiliary signal from command entity **21**. The internal connections of the circuit of block **20** are given in FIG. 4, keyed to the reference numerals within the block. FIG. 4 shows a monostable multivibrator as illustrative. Other relaxation oscillators and devices of similar nature may be substituted for the circuit to be electrically adjusted according to this invention.

The first resistive element is resistor **22** in FIG. 1. Capacitor **23**, in series therewith, is the second component of the time-constant circuit. In FIG. 1 these elements determine the period of relaxation of the monostable multivibrator detailed in FIG. 4. The capacitor connects to internal connection **4**, the resistor to **3** and also to **16**, which in turn is connected to terminal **24**. This terminal represents a source of positive voltage supply (not shown) the negative terminal of which is connected to ground. A voltage of **12** volts is typical for this source.

The second resistive element is resistor **25** in FIG. **1**. This resistor also connects to internal connection **3** and also to the collector of transistor **26**. This may be a PNP transistor, such as a **2N3250**. The collector completes the circuit for resistor **25**, through emitter connection to positive supply terminal **24**, placing resistors **22** and **25** in parallel. This takes place when the base of transistor **26** receives an enabling signal from the command entity **21**. Such a signal may be a decrease in the bias upon the base of **3** volts. At normal bias transistor **26** is non-conductive, at a bias three volts less it is fully conductive. Typical values for resistors **22** and **25** are in the thousands of ohms, as in the range of from 10,000 to 50,000 ohms. Thus, the small internal resistance of transistor **26** when it is conducting is negligible. A typical value for capacitor **23** may be in the range of from a small fraction of a microfarad to less than one-thousandth of a microfarad.

The exact circuit and mode of operation of command entity **21** is not significant with respect to the present invention. It is merely to give an alteration of bias to the base of transistor **26** to cause the transistor to conduct when a reduced time constant is desired, and vice versa. The return circuit is to ground, which is common throughout the circuit as a whole. In its highest usefulness the output from the command entity occurs because of an alteration in the mode of operation of circuits associated with the circuit of FIG. **1**. Such alteration requires a change in the time-constant of the circuit of FIG. **1**, as to increase the frequency of oscillation of a relaxation oscillator for a decrease in the period of the time constant, to increase the rapidity of actuation of a monostable multivibrator (reduce the delay time), or to similarly alter the function of any circuit involved with a time-constant circuit for block **20**. Such a system is fully automatic and does not need manual alteration of the time-constant, which might be impossible in unattended apparatus.

FIG. **2** follows the technology of FIG. **1** except that provision for adding either or both of two additional resistors to decrease the time-constant of the resistor-capacitor circuit has been made. This makes available four different time-constant values. The short dotted line aligned with the transistors in FIG. **2** indicates that by the structure set forth in that FIG. **2** a third transistor and resistor may be added, a fourth, etc., etc., thereby providing a great number of values of time-constant if this is desired.

All of the elements shown in FIG. **1** are repeated in FIG. **2**, and with the same identifying numerals, save command entity, which is now **21'**. This give forth two outputs now, independently available. The additional output, via conductor **28**, connects to the base of additional transistor **29** for controlling the conduction thereof in the same manner as before. The collector of transistor **29** is connected to third resistive element **30**, the second terminal thereof being connected to internal connection **3**. The emitter of transistor **29** is connected to positive terminal **24** as before. Internal connection **16**, also connected to terminal **24**, completes the circuit of each of the series configurations of resistor and transistor so that the time-constant circuit will be effective in the internal circuit of device **20**.

FIG. **3** is the schematic diagram for accomplishing something quite different from the accomplishment of FIG. **2**; the control of two time-constants in separate circuits by one control means while retaining isolation of the circuits. The invention is merely applied in a different manner.

Two circuits, **20** and **20'** are now involved. For simplicity these have been taken as substantially the same, and in accordance with FIG. **4** herein. It is not necessary that this be so; only that each be suited to control by an external time-constant circuit. For block circuit **20** these are **23** and **22**, as before, with **25** the resistor that is added. For block circuit **20'** these are similar, but bear the numerals **32**, **33** and **34**, respectively.

As practiced, the delay provided by circuit **20'** was about one one-hundredth that of circuit **20**. For circuit **20** resistor **22** had a value of 56,000 ohms, resistor **25** a value of 8,200 ohms, and capacitor **23** a value of 0.039 microfarad. For circuit **20'**

resistor 32 had a value of 56,000 ohms, resistor 34 a value of 27,000 ohms, and capacitor 33 a value of 390 picofarads.

Command entity 31 had an output more than was required for actuating the transistor 36; i.e., when a positive voltage of 24 volts was reduced to 18 volts, a change of 6 volts. Accordingly, a voltage divider comprised of resistors 37 and 38 connected between the output and ground was employed. Resistor 37 had a resistance of 8,200 ohms and resistor 38 of 10,000 ohms. Resistor 39, of 10,000 ohms is in series from the common connection between resistors 37 and 38 and the base of transistor 36. It acts in conjunction with diode 40, connected from the base to terminal 24, with the anode of the diode connected to the base of the transistor. The function of the diode is to limit the reverse base-emitter voltage of the transistor to 0.6 volt.

A first unilateral conductor, diode 41 in FIG. 3, is connected with cathode to second resistive element 25. A second unilateral conductor, diode 42, is similarly connected to additional resistive element 34. The anodes of each of these are connected together and to the collector of transistor 36. A further resistor 43 connects from that collector to a source of negative voltage, indicated by terminal 44. A voltage of minus 12 volts is suitable and the positive terminal of the power supply (not shown) is connected to ground. A resistance of 100,000 ohms for resistor 43 is suitable. Capacitor 45 is connected from the anodes of the diodes to ground, has a capacitance of 0.1 microfarad, and is present for the purpose of reducing "noise" in the circuit; i.e., unwanted fluctuations of relatively high frequency.

The above circuit is proportioned so that diodes 41 and 42 are back-biased (i.e., non-conductive) when resistors 25 and 34 are not to be included in the time-constant circuits. This is accomplished by the negative voltage source 44. However, when transistor 36 is rendered conductive by a command signal on its base the resulting equivalent connection to positive voltage source 24 overcomes the negative potential from negative source 44 and a positive voltage exists at the anodes of both diodes 41 and 42. This reduces the impedance of the diodes from substantially an open circuit to a very low value in relation to the resistance of the resistors and these are therefore in circuit. As soon as the command signal leaves the situation is reversed to its initial state.

In addition to the circuit postulated for the command blocks 21, 21' and 31 thus far it will be realized that these may be actuated from associated equipment by electrical energy in the form of pulses. In this instance the command circuits include latching circuits, which place a given bias on the output upon receiving one pulse and remove it upon receiving a second pulse. Depending upon the nature of the pulses available and the nature of the latching circuit employed the second pulse may be of reverse polarity to the polarity of the first pulse, or it may not be.

Diodes 41 and 42 may each be of the 1N4148 type.

FIG. 4 gives the schematic diagram for an illustrative circuit for the 20 and 20' blocks in the previous figures. This is a "one-shot" or monostable multivibrator, an integrated circuit manufactured by Amelco Semiconductor (Co.). Since this is a commercially obtainable product, being Type 342, only the significant aspects of the circuit will be described, particularly with reference to the previously mentioned "internal" connections shown within the blocks. These are the external connections when considered from the viewpoint of the circuit within the block.

In FIG. 4 NPN transistors 50 and 51 are the basic transistors of the monostable multivibrator. In the cross connection between the two, terminals 3 and 4 are interposed. It is here that this part of the internal circuit is completed by capacitor 23 of this invention. Similarly, resistor 22 is connected between terminals 3 and 16. Both of these external elements are shown dotted in FIG. 4 for completeness.

The five other transistors shown are for purposes of isolation and amplification. That is, transistor circuit 50,51 is isolated from various impedance values of both loads and input circuits by these transistor circuits. In this way the basic circuit performs consistently as to timing and other aspects regardless of external impedances. Also, to provide reasonable power to drive subsequent circuits certain of the transistors not only give impedance isolation but also give power increase.

External trigger connection 6 may be regarded as the input to the monostable multivibrator. It is here that a pulse is impressed prior to the delay of the same that is sought by the use of this circuit. This triggers the monostable multivibrator from one state to the other.

The output circuits are 2 and 5, also known as Q and $\overline{Q}$. The Q circuit goes positive when the monostable multivibrator is triggered and remains positive for the duration of the time-constant provided by this invention. The $\overline{Q}$ circuit goes negative for a similar period. These output circuits have been shown in the several figures herein, but use circuits connected to the same have not been shown since these may take many forms depending upon the purpose involved and are not pertinent to the invention.

Circuit connection 16 is supplied with positive voltage for operating the internal circuit by connection to source terminal 24, as in FIGS. 1–3. External connection 8 is the ground return.

In FIG. 3 where two circuits are shown, circuit 20' is a duplicate of circuit 20. Input circuit 10 is the same as prior input circuit 6. Input pulses to either are provided with respect to ground and the output is similarly taken as a voltage variation with respect to ground. Time-constant terminal 12 is the same as terminal 4 and 13 is the same as 3. Output terminal 14 is the same as prior output terminal 2, and terminal 11 is the same as 5. All of the output terminals need not be used in any particular application. The internal functioning is not altered in such a circumstance. Terminals 16 and 8 are carried through to circuit 20'.

Circuit 20, may, of course, be an encapsulated circuit or a circuit formed of separate components instead of having the integrated form. It may also be simplified or modified to other circuits requiring an external time-constant circuit with electrical control for the changing of the time-constant.

Hereinafter, the first means to connect the second resistive element in series with the pair of current-carrying connections is the conductor between resistor 25 and the collector of transistor 26, while the second means to connect comprise the conductors from the emitter of transistor 26 to terminal 24 and from resistor 25 to the connection of resistor 22 to terminal 3.

I claim:

1. Electrical means for reducing the time-constant for an electrical circuit (20), comprising;

a. a first resistive element (22) connected to said electrical circuit and determining in part said time constant,

b. a second resistive element (25),

c. a semiconductor device (26) having a pair of current-carrying connections and a control connection,

d. first means to connect said second resistive element in series with said pair of current-carrying connections,

e. second means to connect the series circuit of said second resistive element and said pair of current-carrying connections in shunt to said first resistive element,

f. command means (21) connected to said control connection to selectively produce conduction between said pair of current-carrying connections,

g. a first unilateral conductor (41) interposed in said series circuit of said second resistive element (25) and said pair of current-carrying connections,

h. a second electrical circuit (20') having an inherent resistive element (32),

i. an additional resistive element (34),

j. a second unilateral conductor (42), and

k. additional means to connect said additional resistive element (34), said second unilateral conductor, and said pair of current-carrying connections in an additional series circuit and to said second electrical circuit (20'),

whereby said command means (31) connected to said control connection of said semiconductor device (36) to selectively produce conduction between said pair of current-carrying connections separately connects said second resistive element (25) in parallel with said first resistive element (22) and also said additional resistive element (34) in parallel with said inherent resistive element (32).

2. The means of claim 1 which additionally includes;

a. a bias source (44),

b. a series impedance (43), and

c. means to connect said bias source through said series impedance to said first and second unilateral conductors

to bias these unilateral conductors into non-conduction save when conduction is produced between the pair of current-carrying connections of said semiconductor device (36).

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